# The policy and science of soil change – a Victorian perspective

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**Abstract**. Understanding and managing soil change is an important component of maintaining soil health and soil security which is important for the future of agricultural productivity in Victoria. Historically, soil policy in Victoria has been dealt with on the basis of a single issue. With the emergence of farming systems thinking, and the concept of soil health and soil security, a more holistic approach is now being taken. A seven-step policy framework has been developed that promotes dialogue between scientist and policy makers. The questions it asks (what is the problem and how can it be solved?) clarify the role of government investment, and developing partnerships between science and policy, enables early identification of potential policy problems and development of appropriate policy interventions to manage soil change and ultimately soil health, soil security and soil productivity.

## 1. Introduction

Soil is formed extremely slowly over centuries from the interaction of biotic activities on the original land surface under the influence of climate, topography, and weathering processes. Soil is constantly being modified under the influence of these natural processes and by human use. Soils are complex ecosystems that form part of or are intimately linked with other ecosystems (such as grasslands or forests).

People have long valued soil mostly for its role in facilitating plant (including crop) growth. The Millennium Ecosystem Assessment [1] more broadly classified the value of all ecosystems to humans through the services they provide as provisioning, regulating, supporting and cultural services. In addition to the recognised role of soil in provisioning services (e.g. crops) it has a fundamentally important direct and indirect role in the delivery of the other services, very often achieved concomitantly. For example, soil can simultaneously sequester carbon, store water and nutrients, and support decomposition and recycling processes [2].

Human activities can greatly influence the services soil can provide. While some of these services provide private benefits, others benefit the public at large. In view of this, and considering the overall value of these benefits, soil management has been an important aspect of public policy, globally, nationally and regionally (including the Australian state of Victoria) for many decades, to both maintain the public benefits and to assist in enhancing private benefits (i.e. via agriculture and forestry).

The term "soil health" is widely used in terms of productive agriculture [2]. Bennett et al. [3] re-examined the concept of soil health in the context of Australian agriculture and found knowledge gaps in areas related to public, rather than to private, good. More recently, McBratney et al. [4] proposed

soil security as a more encompassing concept that should include soil health as one of its parameters. They defined soil security as being "concerned with the maintenance and improvement of the global soil resource to produce food, fibre and fresh water, contribute to energy and climate sustainability, and maintain the biodiversity and overall protection of the ecosystem". Maintaining and improving agricultural productivity depends on good soil health and relies on maintaining soil security. From a state government perspective, declining soil security in Victoria would adversely affect agricultural productivity and other ecosystem services, with a negative financial impact on both Victorian and global food security.

The Government of Victoria recognises that Victoria's soils are vital to the continuing environmental, social and economic prosperity of the State [5, 6]. The government also recognises that healthy soil is the foundation of many key ecosystem services, including the protection of land, water and biodiversity, and contributes directly to the habitat for Victoria's celebrated flora and fauna [6]. Victoria's soil currently generates over $9 billion worth of agricultural exports each year, accounting for 29% of Australia's total agricultural exports from just 3% of Australia's land mass, and enhancing regional and local economies across the state [7].

The Victorian Government has legislative requirements for reporting on change in soil condition under the *Catchment and Land Protection Act (1994)* by the Victorian Catchment Management Council and the *Commissioner for Environmental Sustainability Act (2003)* by the Commissioner for the Environment. Both report every five years. This reporting is important in providing measurements of change in soil condition that might trigger government intervention. However, although there is a requirement for regular reporting there is no systematic funding program for the monitoring and measurement of soil condition [8]. Hence, the methodologies used and sites sampled are not necessarily consistent between reporting periods making valid comparison difficult.

Victoria's soil resources provide the basis for generating many benefits and make a significant contribution to Victoria's economic, environmental and social wellbeing. These benefits are both private and public in nature, and are trans-generational, in that the benefits exist for both current and future generations. As such, there are many parties that have a stake in the sustainable use, management and protection of Victoria's soil resources and the interests of these parties can sometimes be in conflict. These situations justify government considering intervention and when there is government intervention, or the possibility of it, there arises a need for policy to guide that intervention.

Roughly 62 percent of Victoria's land is managed privately, and nearly 90 percent of this is in some form of agricultural land use. As well as its lead role in the management of public land, the former Department of Environment and Primary Industries (DEPI)[3] had a lead government agency role for management of soil health on private land. By comparison with other Australian jurisdictions, DEPI made significant investments in soil health in policy, research and practice change [9].There are strong linkages between policy, research and practice change in that all three components inform each other. The focus of this paper is the way in which research (or science) informs policy, and vice versa, for agricultural soils in the Victorian context.

## 2.  A brief history of Victoria's soil policy and governance arrangements

Victorian government policy, requiring implementation through investment and action, in relation to soil change and soil health outcomes has evolved over the decades in response to different drivers and different government philosophies. DEPI was established in 2013 through the merger of the former

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[3]Following the November 2014 Victorian State election, DEPI was divided between the Department of Economic Development, Jobs, Transport and Resources, and the Department of Environment, Land, Water and Planning. Agriculture has moved to The Department of Economic Development is responsible for agriculture, which includes soil on private land.

Department of Primary Industries (DPI) and Department of Sustainability and Environment (DSE). Both of these Departments had a role in soil health outcomes, which in turn partly reflected the predecessor organisations from which they arose (VAGO, 2010). From 1st July 2013, government responsibilities for soil health was shared between DEPI, the 10 Catchment Management Authorities, the Environment Protection Authority Victoria (EPA Victoria) and Parks Victoria. DEPI is the principal agency responsible for developing soil health policy. Other agencies, including the Victorian Catchment Management Council (VCMC) and Commissioner for Environmental Sustainability are responsible for reporting on the management and condition of land and water assets including soil. The VCMC also has a legislative role in advising the Minister on catchment matters including soil.

The former Department of Primary Industries (and historically the Department of Agriculture) always had a focus on supporting productive agriculture, and developing soil management practices that supported productive crop and pasture production. In doing so, there was often a focus on addressing production constraints, and various issues arose and fell in prominence over time (i.e. trace element deficiencies (1950s) [10], acidification [11] and waterlogging [12] salinity (1980s) [13]), soil structure (1990s) [14] subsoil constraints (2000s) [15,16,17], soil organic matter (2010s) [18,19,20].

The former Department of Sustainability and Environment (and historically the former Soil Conservation Authority) had a greater focus on soil protection, land degradation and water quality issues, partly from a productivity (private good) perspective, but just as importantly, from an environmental (public good) perspective. The soil erosion focus of the 1950s, a consequence of wind and water events which led to the formation of the Soil Conservation Authority [21], was superseded by the salinity focus of the 1990s [22] and the concurrent Decade of Landcare [23, 24] and subsequent Salinity Action Plans [25, 26]. The Government of Victoria created Catchment Management Authorities (CMAs) in the mid-1990s to be important delivery partners and instruments of government intervention at a local and regional scale. The CMAs operate in a regional partnership structure with Department of Environment, Land, Water and Planning, the Environment Protection Authority, Parks Victoria and local councils as well as local stakeholders and land managers. State and federal funding for CMAs is directed to on-ground soil health works on private and public land and stream and rivers, and to whole-farm planning activities on private land. Funds are invested through CMAs according to the priorities defined in their respective Regional Catchment Strategies (RCSs).

In the last decade, there has been a policy shift away from addressing individual soil problems to managing soils as complex systems that produce services that benefit society, i.e. an ecosystem services approach [27].

The 2004 Parliamentary Inquiry by the Victorian Parliament's Environment and Natural Resources Committee into the impacts and trends in soil acidity [28] resulted in a step change in government soil policy. This inquiry concluded that acid soils were a major economic and environmental challenge, and that a comprehensive acid soils management strategy was needed (with associated investment). The government response concluded that it was unwise to focus on a single issue (acidity) as that approach led to a single strategy response (liming), while other issues remained unresolved or unmanaged [29]. The response, informed by close collaboration between former DPI's policy and science staff, established that a better approach was to consider the soil resource holistically by focusing on the issue of 'soil health'. The response postulated that the underlying causes of decline in soil health on private land, their impact on productivity, and interactions between soil, water and wind are often extremely complex and variable. It also recognised that there is no universal formula for managing soil health and that an adaptive management approach was needed [30].

These conclusions led to the development of former DPI's Soil Health Policy Framework for Productive Agriculture [31]. The purpose of this framework was to clarify the role of DPI in soil management for productivity on private land and to encourage the practical application of sound policy principles to making investment decisions. Along with the former DSE Soil Health Strategy [32], it continued to set the basis for DEPI's interventions and investment in soil and soil health related research, extension, and policy. The regulatory framework for soil continues to be the *Catchment and Land Protection Act (CaLP) (1994),* the *Water Act (1989)*, and the *Commonwealth Water Act (2007).*

Within Victoria, there are other contributors to this area beyond DEPI. A number of CMAs have developed Regional Soil Health Strategies. The last two iterations of Regional Catchment Strategies have tried to establish regional soil priorities (but to varying levels of success). The CaLP Act outlines CMA and VCMC reporting responsibilities that could have a key role in tracking soil change and evaluating the success of policies. Similarly, the Commissioner for Environmental Sustainability has a role in SoE reporting. The CaLP Act also outlines the formal role of the VCMC in providing independent advice to the Minister on land and water issues and makes provision for the potential role of "land management notices" requiring a landholder to undertake actions that prevent unreasonable amounts of soil loss from impacting on neighbours or adjacent assets). All of these influence, or provide the context for, soil policy and governance arrangements on agricultural land.

## 3.  The current context

The historical analysis shows that government intervention in soil management has been strongly influenced by the need to address the issue of the day, or to put it more strongly, crises (e.g. erosion, salinity).

In some cases, government intervention, along with private action, has helped to ensure that an issue once seen as a major problem is less significant now than it was in the past. A key example of this is erosion. Research by DPI that measured the adoption of conservation farming practices in northwest Victoria reveals that the proportion of paddocks under conservation management nearly doubled from around 44 per cent in 1996 to over 82 per cent in 2009 (and up from 0 per cent in the 1950s) [33]. This has greatly reduced the risk of wind erosion from these lands, and the occurrence of dust storms is now much less than it was in past decades [33].

In other cases, the crisis was either overstated (maybe because scientific understanding of the problem was limited) or the ability to address the crisis was overestimated. A key example of this is dryland salinity. Two decades ago, the 'rising flood' of dryland salinity was forecast to overtake large areas of productive agricultural land, and widespread efforts were instigated to prevent this (e.g.[34]).Today, in response to improved knowledge of groundwater systems and processes including their response to wetter and drier phases of climate, the forecasts have been revised down significantly, and there is a better understanding of how to manage and influence these processes through soil and land management. The current accepted view is that salinity is a part of the landscape and that Victorian private and public land managers need to learn and have learnt how to manage and adapt to living with it [35]. Government activity, informed by policy and science, now concentrates on realising opportunity and potential for productivity gains. In response to a range of drivers, from November 2010, Victorian government agricultural investment was driven by the policy of doubling food and fibre production by 2030 [36]. Whilst this appeared an audacious goal, analysis showed that it was possible in some sectors, and that the benefits to the economy would be significant. A productive soil resource is recognised as one of the contributing components to achieve this goal.

There is also a realisation by most stakeholders that there are many win-win solutions in soil management. An output from better soil management (e.g. reduced acidity or increased soil organic matter) may lead to improved productivity outcomes, and often also positive environmental outcomes (e.g. increased soil organic matter means carbon has been sequestered in the soil). Further, because the majority of Victoria's soil is under some form of agricultural management, achieving significant environmental outcomes requires interventions to be undertaken in an agricultural context. Government interventions on private land that rely on voluntary action must target productivity drivers to achieve both productivity and environmental outcomes. Where this is not possible, the delivery of environmental outcomes may be encouraged by a system that pays farmers for non-agriculture services.
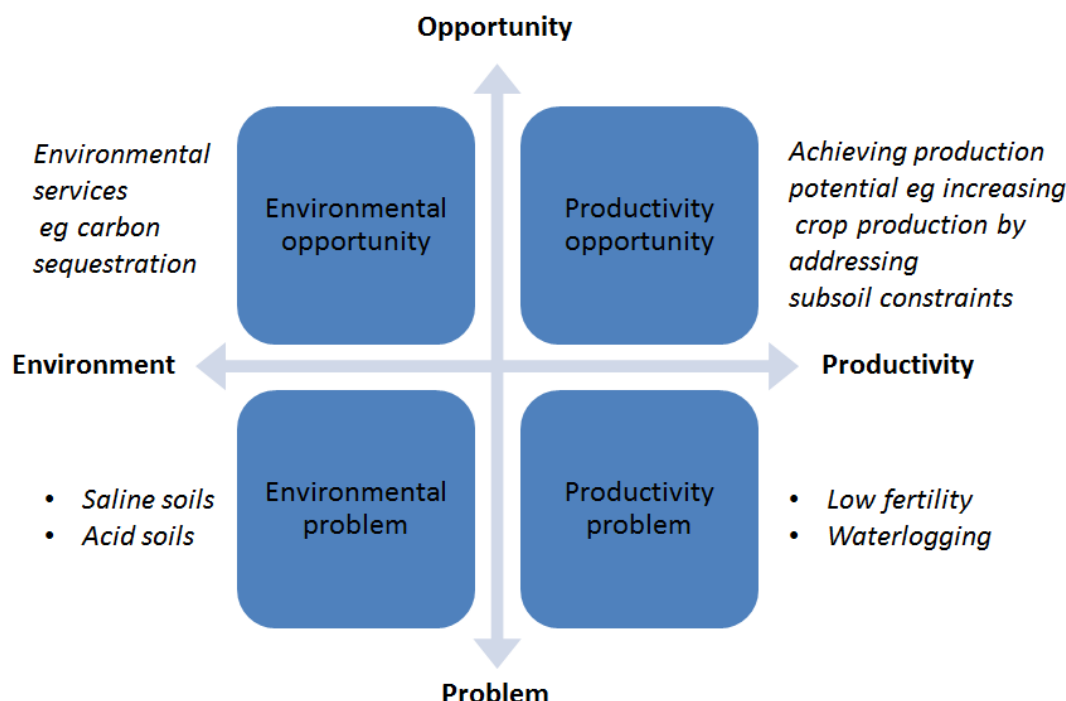
**Figure 1**: A conceptual model of the drivers of soil policy, showing the ecosystem services continuum from environment through to productivity.

What this history shows is that the drivers for government policy and investment in soil health have changed over time. The major driver at any one time shifts between problem and opportunity and between environment and productivity (Figure 1). Hence, the focus has moved over time from addressing productivity and environmental 'problems' to trying to create 'opportunities', environmental and now productivity, through enhanced soil management. In the agricultural context, maintaining the environment (as defined by soil security), is essential to maintaining and increasing productivity. Cycles change. In the Victorian context, community views are important and influence policy. It is possible that in future, environment will be more prominent than productivity in response to community expectations and environmental reporting will increase, hence increasing the focus and emphasis on monitoring and managing soil change.

## 4.  The future

A key element of future activity in soil science in Victoria is the National Soil Research, Development and Extension (RD&E) Strategy [37] that was launched in March 2014. Developed under the auspices of the National Primary Industries Research, Development and Extension Framework, this strategy brings together the various investor and provider partners in Australian soils RD&E. It has sought to identify what will be some of the 'big' policy issues in Australia and how they can be informed by improved soil data, information and knowledge. In turn, the strategy helps to identify the research priorities, the capabilities needed to address these priorities, and the current state of the nations' capabilities to respond to these needs. From a Victorian perspective, this is a key document in helping to shape the ongoing relationship between soil science and policy. Strategic goals of relevance to Victoria is improving the effectiveness of co-investment to generate and apply new knowledge, improving quality, availability and access to soil data and information and improving communication

and exchange of soil knowledge. Other drivers of Victorian agricultural and food policy are the rise in Asia's middle class, coupled with increased access to new markets made available through free trade agreements with Japan, Korea and China, presenting enormous growth opportunities for Australian food and agriculture industries.

The interaction between the National Soil RD&E Strategy and the Victorian government's objectives for food production is under review. One issue to resolve that is relevant to this paper is the high level priority in the National Soil RD&E Strategy on "how to improve the mapping, modelling, monitoring and forecasting of soil-related issues" and how much emphasis is placed on this in Victoria relative to other objectives.

## 5.  What does policy want from (soil) science?

There are many theoretical approaches to the development of public policy, but they largely represent variations on the following seven-step framework developed for the former DPI Soil Health Policy for Productive Agriculture [38] (DPI, 2012):

1. Establish the nature and significance of the problem or opportunity
2. Identify potential market failures
3. Identify objectives and policy options to achieve them
4. Identify implications for private action
5. Assess policy options and developing key performance indicators
6. Identify and design delivery methods and prioritise resources
7. Design and conduct annual reporting and tailored evaluations of the research, development and extension being undertaken to address the problem.

Government can use a variety of instruments and approaches to manage soil health. These include information generation and provision (R&D and extension), regulation, direct government provision of on-ground works, grants and cost-sharing arrangements (subsidies) and other market-based approaches (e.g. fees, levies, trading). Often a mix of these instruments is most appropriate. The distinction between legacy issues and current practices can also be important in determining which mix of policy tools is most appropriate.

Different farming systems, climate, landscape and soil provide the context for prioritising the parameters for measuring change in soil regionally. In Victoria, this is undertaken through the Regional Catchment Strategy process managed by the ten CMAs. To be fully effective, it is necessary to have data, information and knowledge at the appropriate scale. It is arguable that this is not currently the case as the current suite of RCSs all outline that their ability to set spatially relevant priorities around soil change is severely handicapped by a lack of data, information and knowledge at a useful scale and context to their region. Work is being undertaken to improve available data (Mark Imhof, pers comm).

When implemented fully and systematically, this approach represents an evidence-based, defendable approach to government intervention (or absence of) and leads to the effective and efficient use of taxpayer funds. However, there are some caveats to this statement, as often the full achievement of some of these steps, even the first one, is limited by the under, or poor, application of scientific knowledge.

Systematically working through the seven-step framework readily identifies the steps where (in a soils context) scientific knowledge can make a contribution to the policy problem. This process can generate questions such as listed below. Policy wants to have answers to the questions; the questions can be asked at any time, and generally answers are expected as soon as possible. Potential questions include:

- Where are the problems (or opportunities)?
- Are the problems new and emerging, or have they been around for a long time?
- How big (how widespread) is the problem?

- Which industries are affected? What does the soil health problem cost agricultural productivity?
- What is the problem's past, current and future impact on public assets?
- Does a solution exist, or does one need to be developed?
- Is the solution cost effective?
- Is the solution adoptable? What are the barriers to adoption?
- Can data on soil condition be accessed quickly and easily? Can it be interpreted quickly and easily?
- Is a visual (spatial) representation of problems by region and industry readily available?
- How is the problem changing over time? How has it responded to past interventions?

The practicing soil scientist (and science manager) will quickly identify that the answers to some of these questions are not always readily available, often cost money, require time to answer comprehensively, and frequently lead to more questions being asked. The challenge therefore is to identify which of these questions is worth answering; do they require that an answer be developed (i.e. through research and investigation), or are they of a nature that could be readily answered if the data and information was already available (i.e. through monitoring and reporting). An ongoing dialogue between policy advisors and scientists is critical to informing these decisions.

Policymakers also look for consistency of knowledge and the ability of scientists to simplify the complex. They also require clear and precise 'plain english' answers to questions related to quantifying the size of the problem, the cost of solving the problem, and the impact that this will have on either ecosystem services or achieving production potential. Soil scientists, like many scientists, "should strive to: understand the policy maker's perspective, practice excellent communication, be solution oriented, find a champion, avoid appearances of vested interest, and be simple, patient, persistent, resilient, responsive and timely" [39].

## 6.  What does (soil) science want from policy?
Whilst science helps to inform policy, policy helps to inform scientific direction and intent, by providing the strategic context for the research. Scientific funding and effort is driven by clearly identified policy priorities that lead to the achievement of agreed outcomes.

In addition to the strategic context that policy provides for science investment, policy also directly engages with science and asks specific questions of science. What is helpful to science is if policy questions are specific, relevant and answerable (albeit with more research), as opposed to vague, unfocussed and unanswerable. Whilst some questions can be answered immediately, others take time. The identification of 'emerging' policy questions and the issues likely to be of increased concern in two to three years can help science to prepare to answer the specific questions when they need to be answered. Again, an ongoing dialogue between policy advisors and scientists is critical.

## 7.  Conclusions
This paper has attempted to describe the journey taken by soil policy in Victoria over the last sixty years. Soil policy has moved from reacting to the single most important issue of the day to a more holistic, systems based approach. This is achieved by using a 'soil health' and in the future, potentially, a 'soil security' lens to respond to the policy objectives of the government of the day. While the elected government sets the policy agenda, ongoing interaction between soil scientists and policy analysts is required to ensure that the policy can be delivered. Dialogue is also important to enable emerging problems to be identified and managed before they become crises. The policy – soil science conversations need to enable the exploration of the new science, to understand the potential for science to deliver both public and private benefits in the form of ecosystem services, (including productivity) to the State of Victoria. As Bouma [40] observed, soil scientists need to consider changing the focus of their thinking from dealing with threats to concentrating on how they can contribute to achieving the goals of the government of the day. In particular, for the context of this

paper and the workshop, a better understanding of critical changes in soil that can affect the economic goals of government, through monitoring, measurement and the application of models in the soil-landscape-farming system nexus.

A well designed and implemented policy framework is an important tool for both parties to use to develop a shared understanding of emerging opportunities and concerns. Clear and concise questions and answers are essential for both parties to work well together.

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